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Remote and Onsite Direct Measurements of Emissions from Oil and Natural Gas Production

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Background

- Emissions from upstream oil and gas production
  - Methane (CH_4), volatile organic compounds (VOCs), and hazardous air pollutants (HAPs)
  - Vary based on basin, age of the well, equipment design, etc.
  - Difficult to measure and model

- Can use cost-effective direct and remote measurement tools to facilitate leak detection and repair, inform inventories, and support compliance activities.

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Outline

- Methane Measurements
  - Remote measurements and variability (EPA)
  - Comparison with onsite (Allen et al. 2013 and ERG 2011)
  - Comparison with production
- VOC and HAP Measurements
  - Difficulties with onsite measurements
  - Remote versus onsite
  - Comparison with modeled tank emissions

Methane Measurements

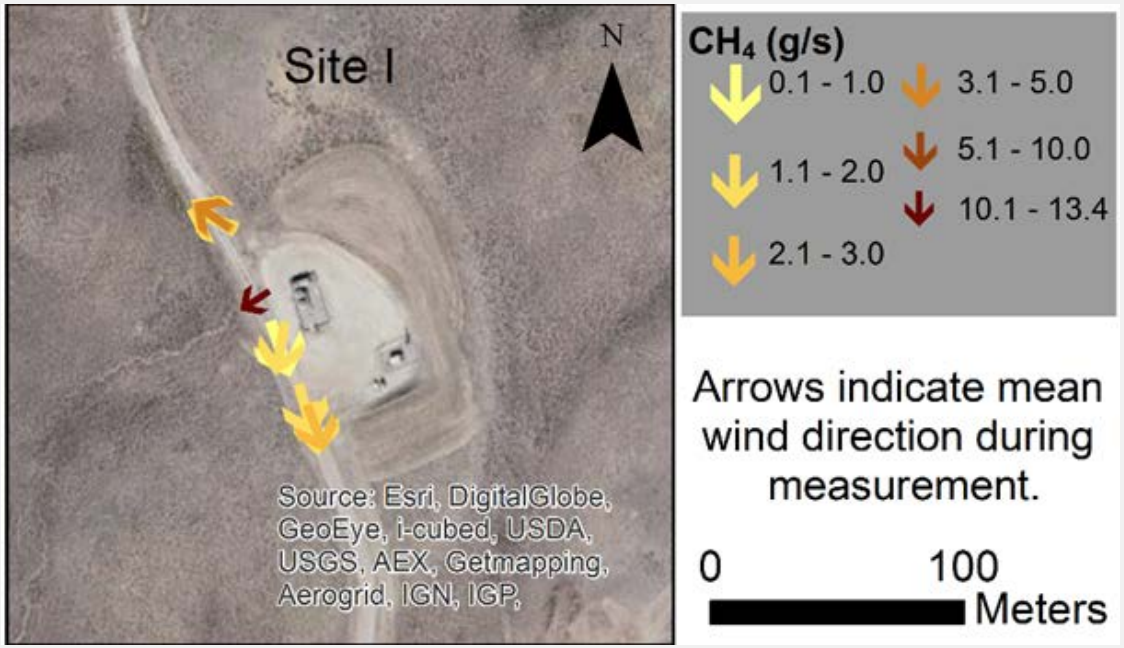
Remote

Onsite

OTM 33A was used to quantify CH_4 emissions remotely at 210 pads in TX, CO, and WY (2010-2013).

Allen et al. (2013) and ERG (2011) used Hi Flow Samplers to directly measure individual leaks at 150 and 388 pads, respectively.

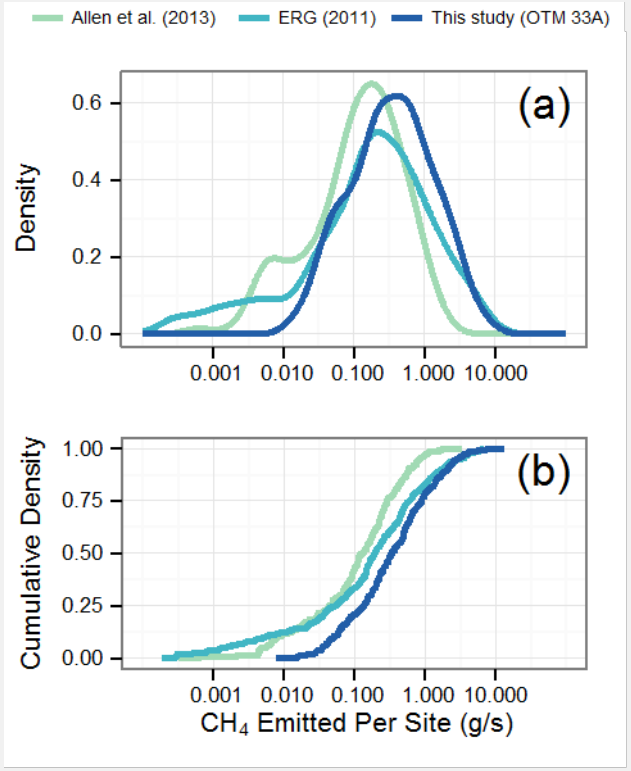
Temporal Variability in Emissions

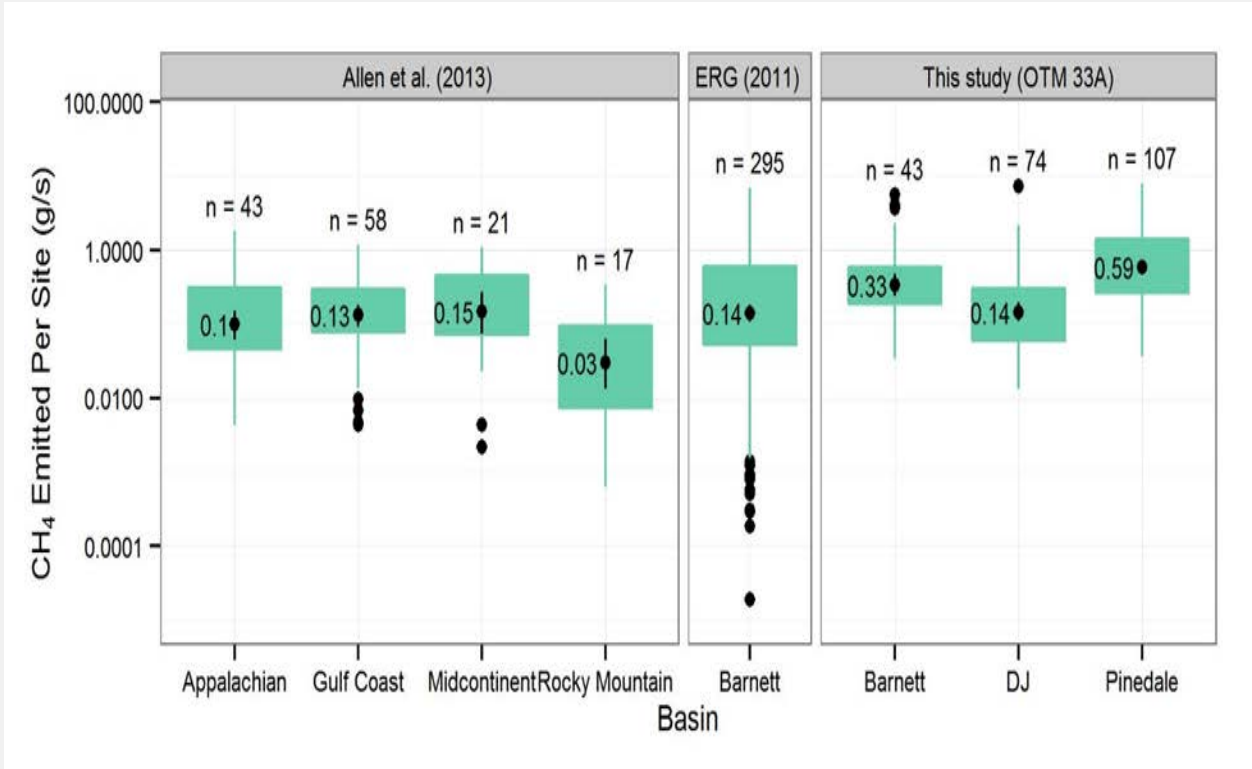


20 min stationary measurements using a mobile platform (SUV) and inverse Gaussian plume dispersion model (OTM 33A)

Open thief hatch on condensate tank

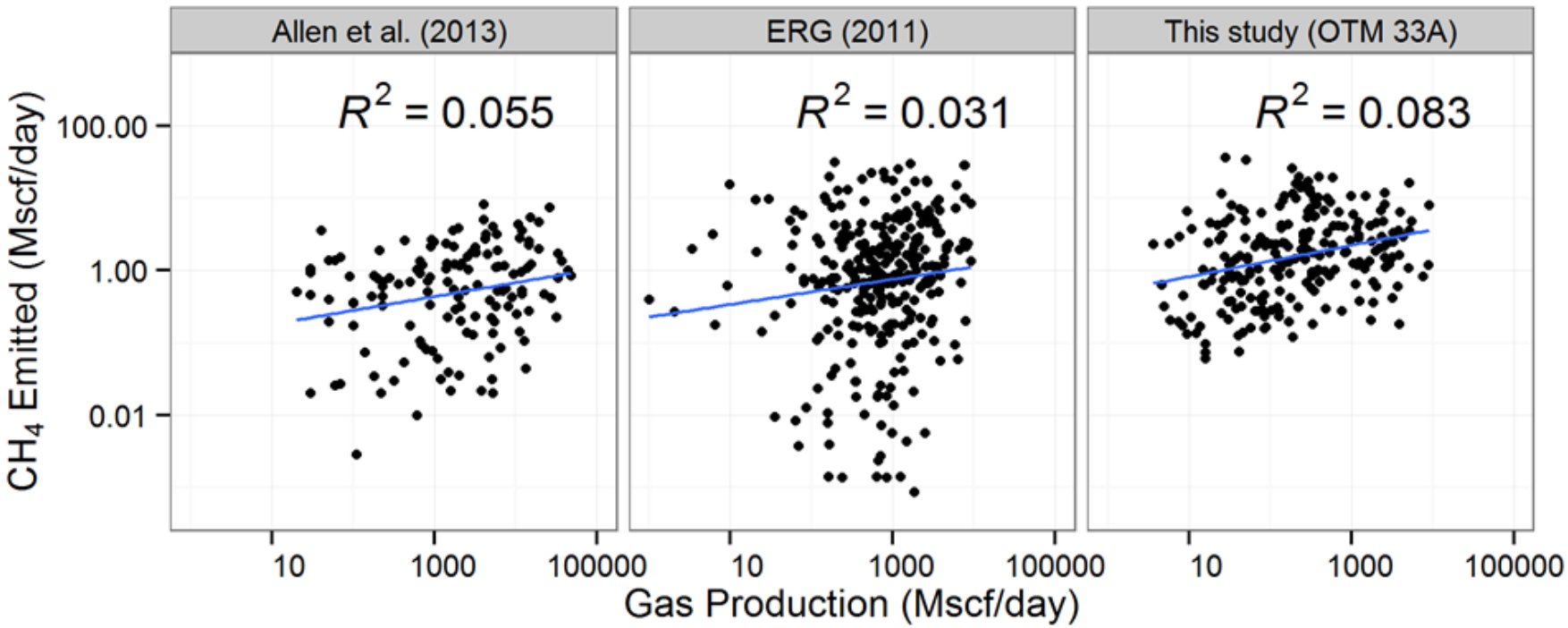
Heavy-tail Distributions (log-scale)





Different measurement techniques capture different aspects of the distribution.
Remote measurements useful for locating high emitters.

Methane Comparison with Production



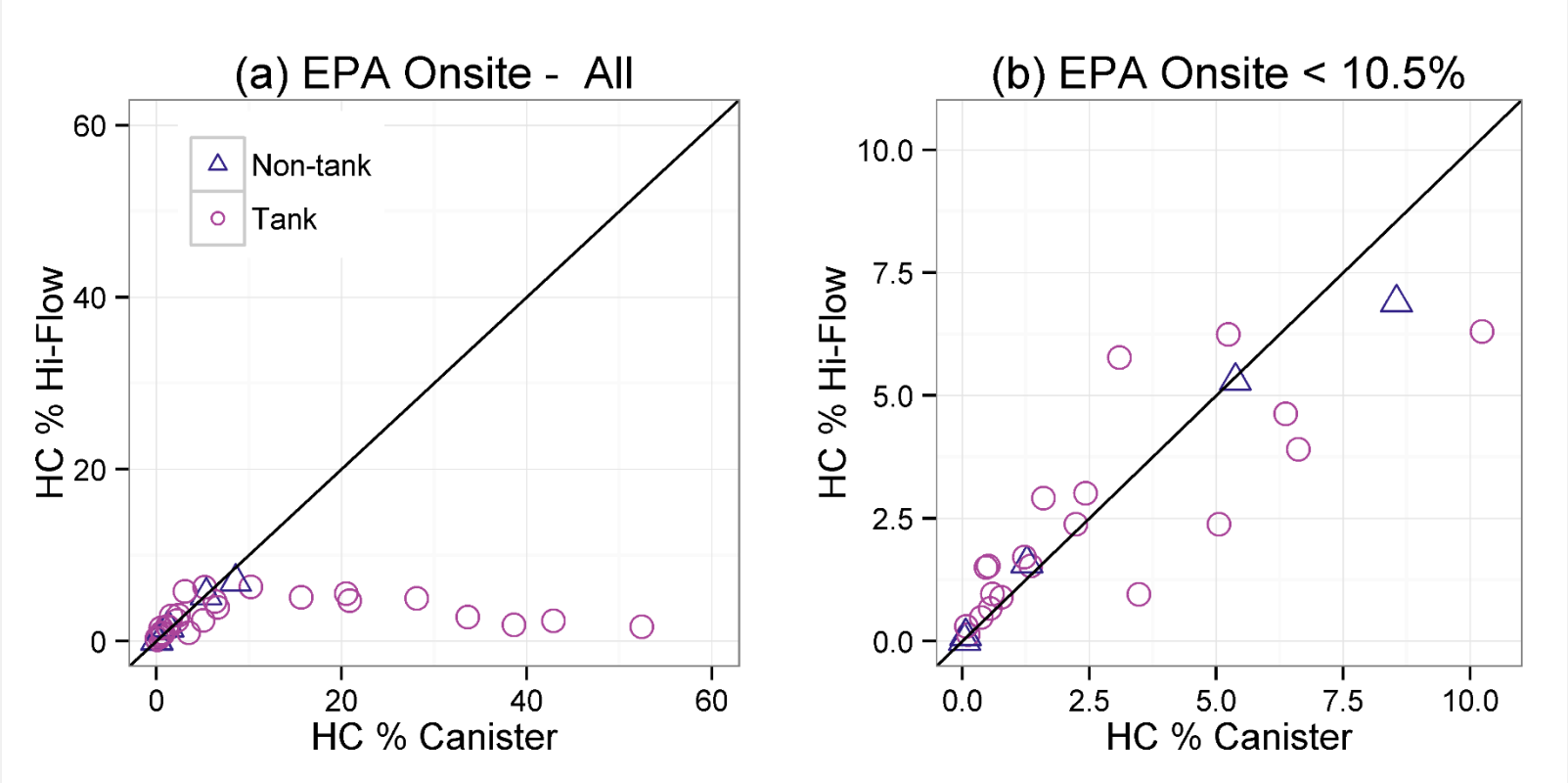
Very little of the variation in emissions is explained by production, most likely due to maintenance, engineering design, and fugitives.

VOC and HAP Measurements

	EPA Onsite	EPA OTM 33A	ERG (2011)	Hendler (2006)	Gidney (2009)	ENVIRON (2010)
Year of Measurements	2011	2010-2013	2010-2011	2006	2008	2010
Basins	Denver-Julesburg	Barnett, Denver-Julesburg, Pinedale	Barnett	Barnett, Western Gulf	Anadarko, Barnett, Permian	Barnett
Unique Well Pads (N)	23	Barnett: 26 Denver-Julesburg : 36 Pinedale: 61	380	Barnett: 10 Western Gulf: 9	Anadarko: 4 Barnett: 7 Permian:8	3
Average Condensate Production (bbl/day)	34.5	Barnett: 0.15 Denver-Julesburg: 6.7 Pinedale: 10.8	0.01 (6 pads with condensate production)	Barnett: 6.5 Western Gulf: 87.8	Anadarko:72.8 Barnett: 22.3 Permian: 510.3	20.9
Controls at time of measurement	ECD[1], VRU[2] condensate tanks	Denver-Julesburg: ECD[1], VRU[2] Barnett: minimal Pinedale: partial	Minimal	None	None	None
Measurement approach	OGI[3], HVS[4] with GC-FID[5] canister analysis	OTM 33A for CH_4 with GC-FID[5] canister analysis	OGI[3], HVS[4] with TO-15 canister analysis	Seal and measure with GPA Method 2286-95[5]	Seal and measure with GPA Method 2286-95[5]	Seal and measure with GPA Method 2286-95[5]
Measurement focus	Component (tank focus)	Integrated pad	Component (leak focus)	Condensate tank	Condensate tank	Condensate tank
Duration of measurement	minutes / point	20 min	minutes / point	24-hour	24-hour	24-hour

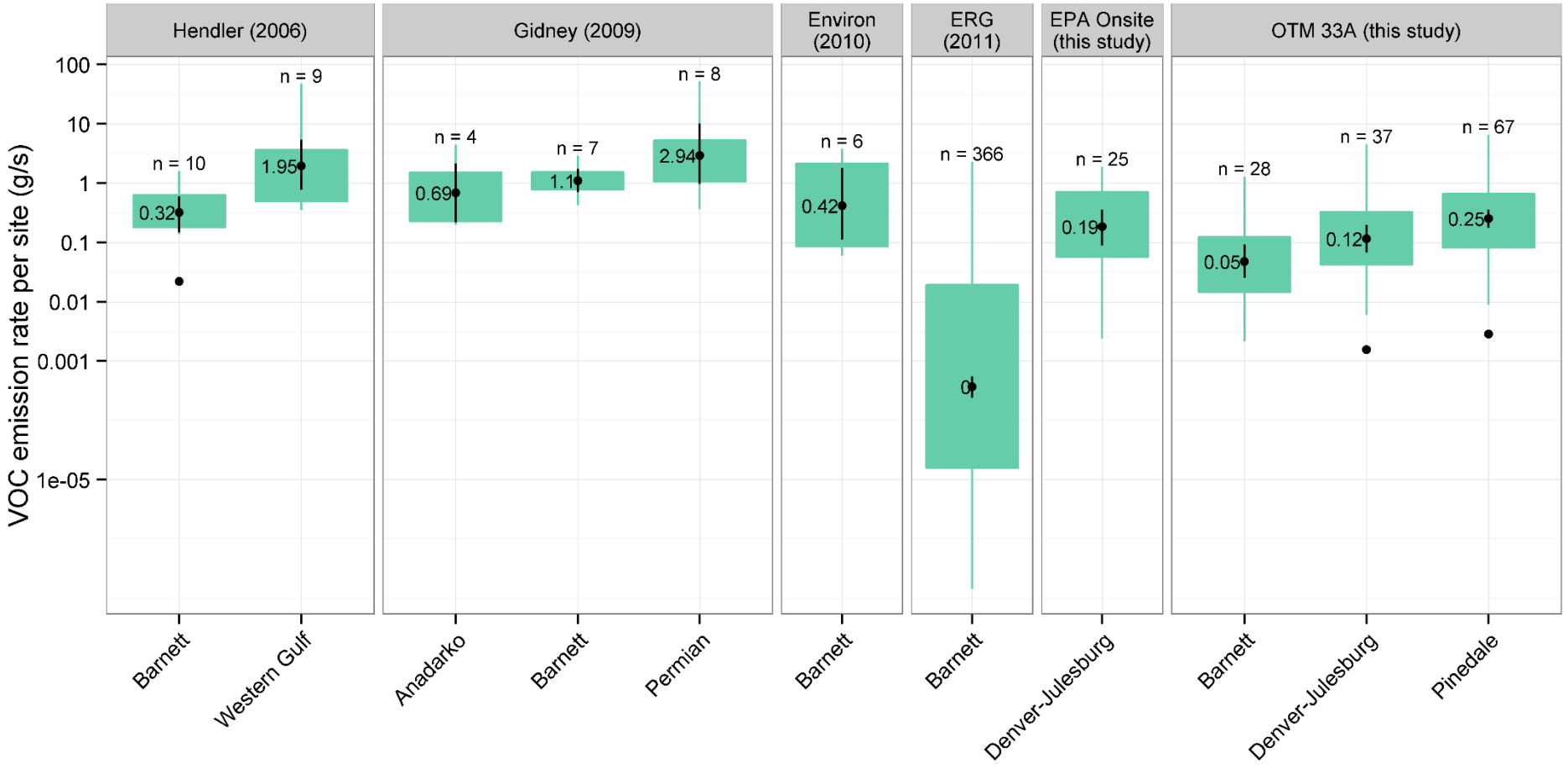
[1] Enclosed Combustor Device; [2]Vapor Recovery Unit; [3]Optical Gas Imaging; [4]High Volume Sampler; [5]Gas Processors Association Method 2286-95 (GPA, 1999) [5]Gas Chromatography with Flame Ionization Detection as described in EPA/600-R-98/161 (EPA, 1998)

Bacharach Hi Flow vs Cannister Results



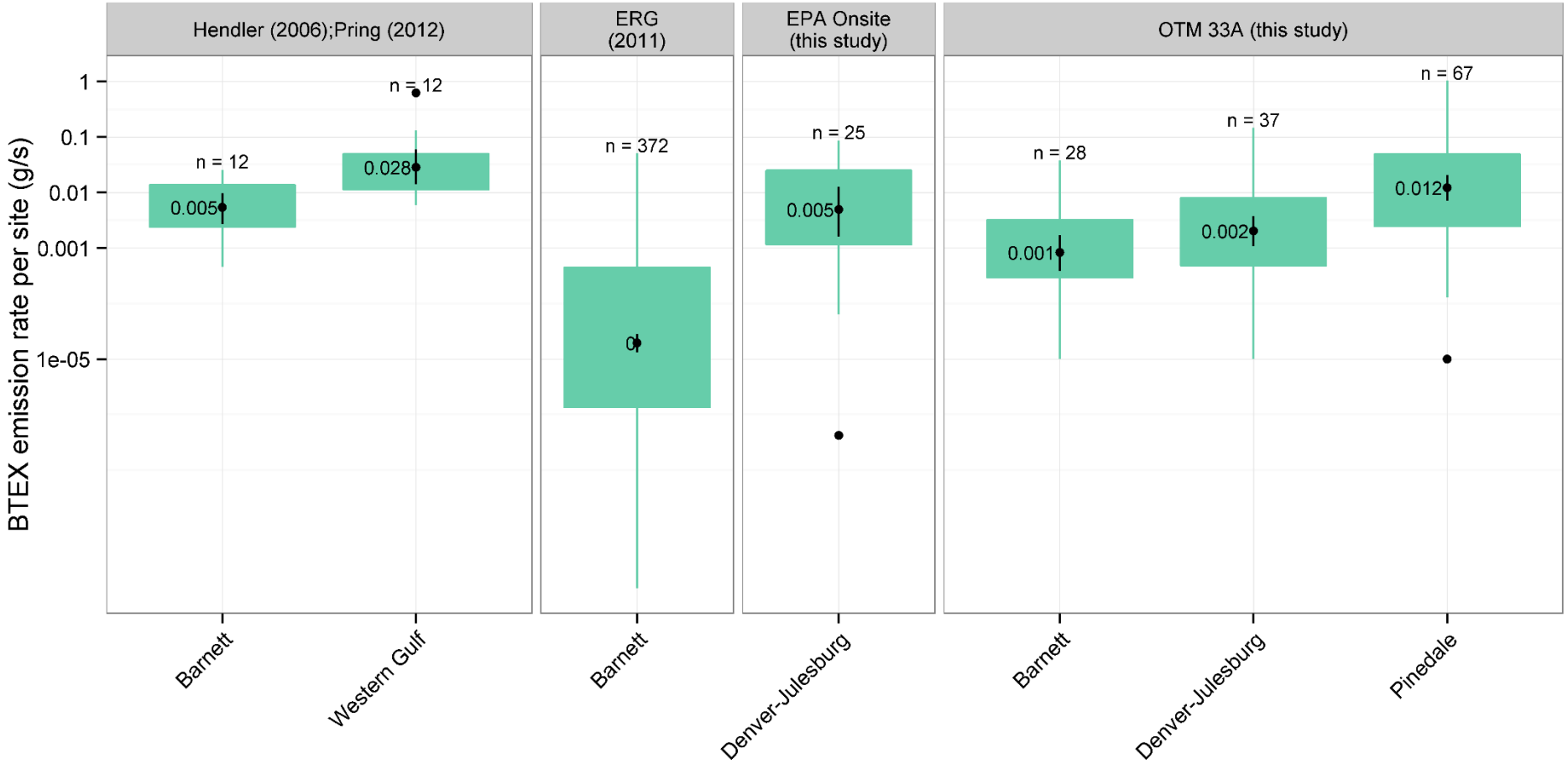
HVS severely underestimates emissions when the HC % is > 10.5

VOC remote versus onsite

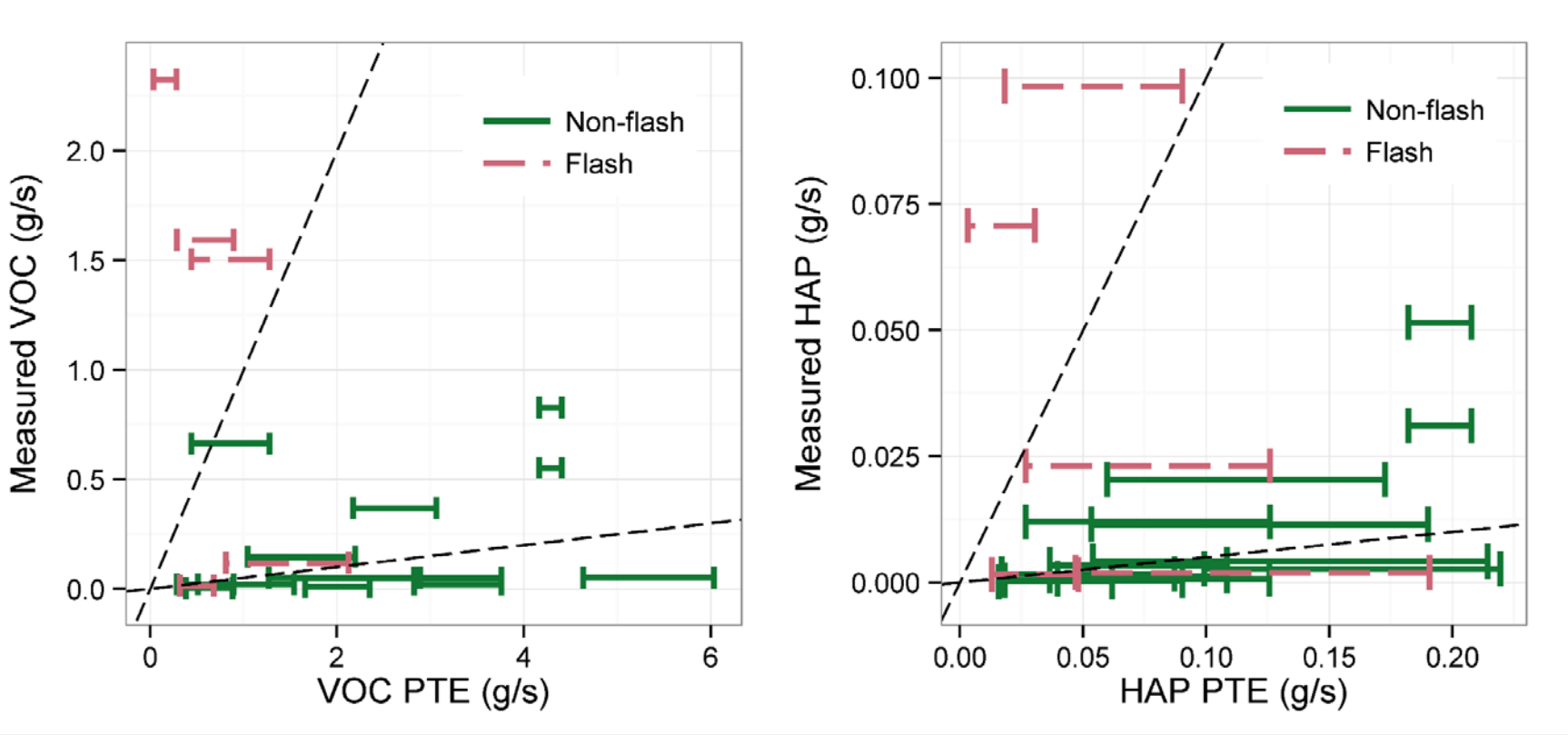


Onsite EPA measurements were similar to remote measurements. ERG (2011) measurements are significantly lower, likely due to choice of compounds used in the canister analysis.

BTEX (HAP) remote versus onsite



Comparison of VOC and HAP measurements with potential to emit values calculated using E&P TANKS v2.0*



Range of ambient temperatures (73.3 to 101 F) and pressures (12.14 to 12.57 psia). Dashed lines represent y=x and y=0.05x.

*(API Publication 4697)

Take-Away (1/2)

Methane Measurements

- Well pad emissions were log-normally distributed (fat-tails)
- Onsite and remote measurements capture different aspects of the distribution.
- Production rates accounted for approximately 10% of the variation in emissions.

Take – Away (2/2)

VOC and HAP Measurements

- The Hi Flow can malfunction and underestimate emissions and may not be suitable for general use in upstream applications.
- Similar results from EPA onsite and remote measurements suggest that remote measurements can be used as an effective inspection technique.
- Significant VOC emissions from controlled systems can occur and are often a result of thief hatch leaks.

Acknowledgements

- Shahrooz Amin, Mark Modrak, and Frank Grainger with ARCADIS, Inc., for field and data analysis support for this project.
- EPA colleagues Bill Mitchell, Mike Miller, Jason DeWees, Robin Segall, and Ken Garing and his team for ongoing support in development of OTM 33.
- Eric Crosson, Chris Rella, and Tracy Tsai with Picarro for ongoing collaboration on mobile measurements.
- Many individuals at Enthalpy Analytical and Sage Environmental Consulting

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